DECLARATION

I, James G. Morgan, a British subject of Markgrafenstr. 8, 81827 Munich, Germany, do hereby declare that I am conversant with the English and German languages and that I am a competent translator thereof.

I verify that the attached English translation is a true and correct translation of the German patent application 195 35 537.7.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed:

J. G. Morgan

James G. Morgan

This 21st day of February 2008

TRANSLATION

(19) FEDERAL REPUBLIC OF GERMANY

GERMAN PATENT OFFICE

(12) Laying open print

(10) DE 195 35 537 A1

(51) Int. Cl.[6]:
B 23 P 11/00
F16 B 19/00

(21) File reference: 195 35 537.7
(22) Date of application: 25 September 1995
(43) Date of laying open: 27 March 1997

DE 195 35 537 A1

(71) Applicant:
Profil-Verbindungstechnik GmbH & Co. KG, 61381 Friedrichsdorf DE

(74) Agents:
Manitz, Finsterwald & Partner, 80538 Munich

(72) Inventor
Müller, Rudolf, 60437 Frankfurt DE

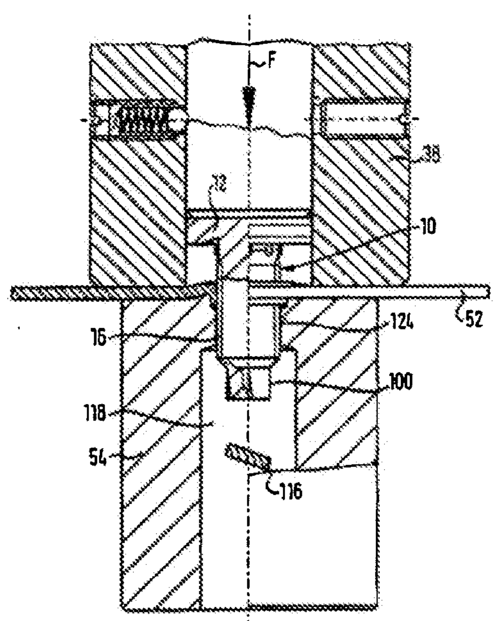
(56) References to be considered relevant for the evaluation of patentability:

DE 40 03 374 C1
DE 34 47 006 C2
DE 30 03 908 C2
DE 44 10 475 A1
DE 43 33 052 A1
DE 35 24 308 A1
DE 33 14 487 A1

Brochure: PROFIL, of Verbindungstechnik GmbH & Co. KG, 61381, Friedrichsdorf, p. 2-4;
BUDDE; Lothar; LAPPE, Wilhelm: Stanznieten ist zukunftträchtig in der Blechverarbeitung. In: Bänder, Bleche, Rohre 5-1991, p. 94-100;

(54) Bolt element, method for using the same, component assembly and rivet die

(57) In a method for inserting a bolt element (10) having a head part (12) and a shaft part (16) into a sheet metal part (52) the bolt element is passed through the sheet metal part by means of a setting head (38), with its end (100) remote from the head part at the front, and is riveted to the sheet metal part (52) in the region of its head part (12) by the cooperation of the setting head with a die (54) arranged at the side of the sheet metal part remote from the setting head (38). The sheet metal part (52) is pierced by the specially shaped bolt element (10), which forms part of the invention, by the end of the shaft part (16) remote from the head part (12) under the action of the setting head (38), and optionally in collaboration with the die (54), while forming a punched slug (116). In this arrangement the end (100) of the bolt element (10) which performs the punching work is preferably executed in accordance with the Ka shape of DIN 78. (Fig. 14)



DE 195 35 537 A1

The present invention relates to a method of inserting a bolt element having a head part and a shaft part into a sheet metal part or into another plate-like component consisting of deformable material, wherein the bolt element is guided by means of a setting head through the sheet metal part with its end remote from the head part at the front and is riveted to the sheet metal part in the region of its head part through the cooperation of the setting head with a die arranged on the side of the sheet metal part remote from the setting head. The invention furthermore relates to a bolt element which can be inserted into a sheet metal part by riveting, a riveting die for the insertion of the bolt element and a component assembly comprising a sheet metal part and a bolt element.

Bolt elements of the initially named kind insertable by riveting into a sheet metal part are already known, in which the shaft part of the element which is formed as a threaded bolt, is introduced from one side into a preformed hole of the sheet metal part and a flange part of the head contacts the sheet metal part at this side. The material of the sheet metal part is subsequently so deformed in a setting process that the material is plastically formed into a very small groove at the shaft part of the element arranged adjacent to the contact surface of the head part, with the element being secured in the sheet metal. In this arrangement the head part of the element has substantially radially extending noses at the contact surface which are pressed into the sheet metal part during the insertion and hereby form a security against rotation. The security against rotation is intended to enable the attachment of a nut to the threaded shaft part without the element itself turning in the sheet metal part.

Such component assemblies consisting of sheet metal parts and elements are frequently used in industrial manufacturing, for example in the manufacture of motorcars or washing machines in order to secure a further component to the component assembly consisting of the sheet metal part and element or vice versa. It is advantageous that the contact surface of the head part lies at the other side of the sheet metal part from the further component to be secured to it so that the sheet metal part is loaded in compression.

The previously known above described elements of the prior art are, however, not fully satisfactory in practise because the danger of the element becoming loose during transport or storage prior to attachment of the further component is relatively large, in particular with rivet bolts which are intended for use with relatively thin sheet metal, with the loosening not infrequently being so pronounced that the element becomes lost or adopts an orientation which is not acceptable for the further machine processing of the sheet metal part. The loosening of the prior known elements of this kind also leads to the security against rotation that is provided not being adequate in many cases, so that the element turns on attachment of the nut before an adequate clamping force can be generated. These difficulties are particularly disadvantageous in bodywork construction and in other areas where the head parts of the elements lie in a hollow cavity and are no longer accessible after the component assembly has been installed. If an element turns under these circumstances, or is lost, then the article to be produced, for example a motorcar, can no longer be manufactured in the context of normal production but must instead be repaired in a more complicated manner. Such circumstances should be avoided as far as possible.

A further problem which is particularly pronounced with thin sheet metal lies in the fact that the noses which form the security against rotation must have a certain height, i.e. a height above the contact surface of the head part in order to achieve the security against rotation at all. With thin sheet metal the material of the sheet metal part is pressed in by the noses to such an extent that the full strength of the sheet metal part is no longer available, which can also lead to difficulties in practice.

It is, moreover, disadvantageous that the fine groove for receiving the plastically deformed sheet metal part during riveting of the element to the sheet metal part is difficult to manufacture and, in addition, makes the bolt unnecessarily expensive. In other respects, this groove also leads to an undesired reduction of the strength of the bolt or of its fatigue characteristics as a result of the sharp edges and the cross sectional reduction of the element which is produced. As a result of the dimensions of the groove an inadequate attachment of

the element to the sheet metal part also arises which makes the above mentioned tendency of the element to become loose in the sheet metal part, or indeed to drop out, even worse.

In order to provide assistance here the object was set in an earlier, non prior published German patent application P 44 10 475.8 of the present applicants of providing an element of the initially named kind which can be manufactured and used at favourable cost, with the danger or the element becoming loose or becoming lost from the sheet metal part being substantially reduced and preferably precluded, with both a good security against rotation of the element in the sheet metal part and also a strong connection being possible, and indeed even when one operates with thin sheet metal or with non-iron sheets, for example sheets of aluminium or its alloys. Moreover, a component assembly comprising a sheet metal part and at least one such element as well as a die and a method of riveting the element to the sheet metal part should be made available.

This object is satisfactorily solved by the subject of the earlier application in that the element has concave peripherally closed fields at its lower side serving as a contact surface which are partly bounded by ribs extending outwardly from the shaft part, with the shaft side ends of the ribs extending in raised form along the shaft part and merging at the ends remote from the head part into at least one recess extending spirally around the shaft part.

Through this design one succeeds during riveting of the element to the sheet metal part by means of a suitable die arranged concentric to the shaft part in plastically deforming the material of the sheet metal part into the concave circumferentially closed fields and also into the said recess without substantial thinning of the sheet metal by the ribs occurring so that the strength of the riveted connection is already substantially increased for this reason in comparison with the previous elements of the prior art. The fact that the shaft side ends of the ribs extend in raised form along the shaft part means that the security against rotation is not only achieved by the material driven into the concave fields but rather also by the form locked connection between these shaft side ends of the ribs and the sheet metal part. This leads to the security against rotation being substantially improved in comparison

to the security of rotation with elements in accordance with the prior art. The fact that the sheet metal part is not unnecessarily thinned during insertion of the element means it is possible to arrange the recess somewhat further from the lower side of the head than is the case with the groove of the prior art so that this recess is also easier to realise from a manufacturing point of view. This also leads to a situation in which the shape of the recess can be made cleaner than was previously the case and ensures that the material of the sheet metal flows fully into the recess during the plastic deformation by means of the die and thus generates an increased resistance to loss of the element.

It is particularly advantageous when the shaft part of the element has a larger diameter in the region of the raised ribs in comparison to the shaft part remote from the head part, with the at least one recess being located in this region of larger diameter. As a result of this design the element is less weakened by the recess so that the normal strength of the element can be more easily fully exploited and, on the other hand, the fatigue characteristics of the element can be improved. The security against rotation is also further improved. Particularly important with this design is, however, the fact that the flow behaviour of the material of the sheet metal can be improved during insertion of the element. The pre-finished hole in the sheet metal part must namely have a diameter which enables the shaft part of the element to be passed through it without the shaft part being damaged. Through the region of greater diameter the sheet metal is initially driven outwardly during insertion of the element because the region of the larger diameter enlarges the hole and this provides additional material which can be driven into the concave peripherally closed fields and/or into the recess. It is also conceivable to conically deform the sheet metal in the area of the hole in accordance with the so-called "clamping hole riveting method" of the applicants (European patent application 92 117 466.0) and to form it into a truncated cone section whereby, after the insertion of the element through the hole provided at the narrower end of the conical deformation of the metal sheet, the latter can be pressed flat again during the further course of the setting procedure and additional material can hereby also be provided to ensure a high-strength connection between the element and the sheet metal part.

The at least one recess which extends spirally around the shaft part can advantageously be formed by a thread groove, in particular a thread groove which represents a continuation of a thread present on the shaft part of the element. In this manner the recess is realised with the same procedure which is used for the formation of the thread. This leads to a substantial cost saving during the manufacture of the element and also to a clean formation of the recess. If, in the preferred manner, the ribs are formed so that they extend in raised form along the shaft part at their shaft side ends prior to the thread rolling process, then these raised rib parts can be straightforwardly deformed during the thread rolling process so that they all finish in the recess. It is, however, on the other hand, entirely conceivable that the raised rib parts are first generated after the thread rolling process in a separate procedure, for example also in a rolling process. In this case the recess could be subdivided into several sections by the raised ribs. The raised parts of the ribs which extend along the shaft part should, however, not be too long because otherwise they could impair a clean seating of the article to be attached. An exception to this would be if the element is intended for the attachment of an electrical terminal. Here extended rib parts could cause a desired notch effect in the hole of the terminal, which would be useful to achieve a good electrical contact.

The spiral recess can represent one or two thread turns and can also be present in the form of thread sections, above all when the recess is formed as a multi-start thread which would be fundamentally possible and belongs to the invention.

The spiral recess has a great advantage in comparison to a circumferentially continuous groove. If, namely, a nut is removed from the shaft part after a period of time, then it must be expected that an increased torque will be necessary to remove the nut as a result of contamination or corrosion of the thread part and/or of the nut. An increased torque of this kind would, however, lead to the element being pressed even harder against the sheet metal as a result of the spiral shape of the recess so that an enhanced resistance to turning of the element is present.

The spiral recess could, however, finally be formed with a pitch angle of 0° , i.e. as a circumferentially continuous groove and recesses of this shape also belong to the present invention. They could, for example, be particularly expedient when the element is not used as a threaded bolt but rather, for example, as a bearing spigot. The above mentioned advantages in accordance with which the recess can be formed in accordance with the invention at a larger spacing from the underside of the head part than is possible in the prior art also apply to the design of the recess as a circumferentially extending groove.

The circumferentially closed field preferably has its greatest depth adjacent to the shaft part, with this being of advantage for the security against rotation and also for the plastic deformation of the material of the sheet metal part during the insertion of the element.

It is also particularly important that the area contributions of the fields, in comparison to the contact surface of the head part, can be so selected that they result in an ideal security against rotation and non-critical surface pressure, taking account of the material pairing. This advantage also makes it possible to use the element of the present invention with softer sheet metals, for example with metal sheets of aluminium or aluminium alloys, which will in future find increasing use in motorcar construction. The problem of galvanic corrosion can be handled nowadays by appropriate surface treatment of the elements, i.e. the galvanic corrosion is avoidable, so that elements of iron materials in accordance with the present invention can also be straightforwardly used with, for example, metal sheets of aluminium alloy.

In this earlier proposal it is, however, necessary to generate a hole in the sheet metal part prior to the insertion of the bolt element which is possible by a punch tool or by drilling. The hole is generated in an earlier working step.

The object of the present invention is to avoid the complication of producing the hole in an earlier working step and in addition to ensure a riveted connection which is qualitatively at

least as good as can be achieved by means of the earlier application and preferably even better and simultaneously to at least largely avoid damaging the thread of the bolt element during insertion of the latter.

In order to satisfy this object a method of the initially named kind is provided in accordance with the invention which is characterised in that the sheet metal part is pierced by the end of the shaft part remote from the head under the action of the setting head, optionally in cooperation with the die, with a slug preferably being formed during penetration of the sheet metal part.

It has been found, in surprising manner, that it is possible to pierce a sheet metal part with the end face of the shaft part of a customary bolt element and to insert the thread of the bolt element through the so formed pierced hole without the thread being damaged to a considerable degree. The method of claim 3 is particularly favourable in which the pierced hole is dilated into a collar surrounding the hole at the die side of the sheet metal part. During the subsequent riveting of the sheet metal part to the bolt element by means of the die the collar material is exploited in order to generate a particular high quality connection between the sheet metal part and the bolt element. It is particularly favourable when, in accordance with claim 3, at least one and preferably a plurality and in particular a non-even number of notches or at least substantially radially directed cuts or tears are generated in the rim of the aperture.

On pushing the thread through the collar these cuts tear further and considerably reduce the force which is required to push the threaded part through, whereby the danger of damaging the thread is also substantially reduced.

Particularly surprising is the finding that the method can be particularly favourably carried out when the end of the bolt element has a so-called Ka shape in accordance with DIN 78. This Ka shape signifies a spigot-like projection at the end of the shaft part remote from the head part with a diameter which is somewhat smaller than the core diameter of the thread.

The end face of the spigot extends at least substantially perpendicular to the central longitudinal axis of the bolt element and a plurality of grooves are provided in the jacket surface of the spigot like-projection, which have a special shape specified in the DIN norm. In the normal case these grooves serve for the centring and alignment of a nut so that nut elements can be set in place by automatic screwing devices without having to fear damage to the thread. In accordance with the invention it has been surprisingly found that precisely this shape is particularly favourable for the piercing of a metal sheet by means of a bolt element.

The bolt element itself is preferably formed in accordance with claim 6 and is characterised in that the shaft part is formed at its end remote from the head part for the piercing of the sheet metal part. Particularly advantageous forms of the bolt element can be found in the claims 7 to 14, and the further claims 15 to 26 embrace the formation of the head part of the bolt element which is to be riveted to the sheet metal part and correspond to claims 1 to 13 of the earlier German patent application P 44 10 475.8.

A riveting die for use with the bolt element can be seen from claim 27 and the claims 28 to 31 relate to the component assembly which arises after connection of a bolt element to a sheet metal part.

The invention will be explained in more detail in the following with reference to embodiments and to the drawings in which the Figures 1 to 9 represent the corresponding Figures from the earlier application P 44 10 475.8 and Figures 10 to 15 show the particular design and method of the present application. In the drawings there are shown:

Fig. 1 a side view of a partly longitudinally sectioned element in accordance with the invention which is provided for riveting to a sheet metal part,

Fig. 2 an end view of the element in the direction of the arrow II of Fig. 1,

Fig. 3 an enlarged illustration of the sectioned part of the element of Fig. 1 as shown in the circle III,

Fig. 4 a partial cross section of the element of Fig. 1 in accordance with the section plane IV-IV of Fig. 3,

Fig. 5 a schematic illustration of the method of insertion of an element in accordance with the invention of Figs. 1 to 4 into a sheet metal part,

Fig. 6 the end stage of the insertion method in accordance with Fig. 5,

Fig. 7 a detailed schematic illustration of the left hand side of a particularly preferred riveting die of the invention for use with the method of Figs. 5 and 6,

Fig. 8 a partly sectional schematic illustration of a component assembly in accordance with the invention consisting of a sheet metal part and an element of the invention riveted thereto, i.e. a component assembly which was manufactured using the method of Figs. 5 and 6,

Fig. 9 an enlarged illustration of the region of the component assembly of Fig. 8, indicated with the circle IX,

Fig. 10 an illustration of the bolt element of the present invention in side view and partly in longitudinal section,

Fig. 11 a representation of the bolt element of Fig. 10 after insertion and riveting to a sheet metal part,

Fig. 12 the method of inserting the element of Fig. 10 into a sheet metal part directly prior to piercing of the sheet metal part,

Fig. 13 the method of inserting the bolt element of Fig. 10 directly after the piercing of the sheet metal part but before the passage of the threaded part through the pierced hole,

Fig. 14 the method of inserting the bolt element of Fig. 10 after dilation of the pierced hole by the thread but before the riveting of the head part of the bolt element to the sheet metal part, and

Fig. 15 the method of inserting the bolt element of Fig. 10 after the riveting of the head part to the sheet metal part.

Fig. 1 shows, initially in side view, an element 10 in accordance with the invention in the form of a threaded bolt having a head part 12 and a shaft part 16 provided with a thread 14. As can be seen in particular from Figs. 2, 3 and 4, the element has concave, peripherally closed fields 20 at its underside 18 which serves as the contact surface. The fields 20 are at least partly bounded by ribs 22 which extend outwardly away from the shaft part 16, with the shaft side parts 24 of the ribs, which are right-angled in side view, extending in raised form along the shaft part 16 and merging at the ends 26 remote from the head part into at least one recess 28. The recess 28 is spirally arranged around the shaft part and is formed here as a thread groove, i.e. as a continuation of the thread 14 of the shaft part 16.

The closed fields 20 are bounded at their radially outer side by a circumferentially extending peripheral surface 30 of the head, with the ribs merging at their radially outer ends into this peripheral surface without steps. At their radially inner side the fields 20 are bounded by a cylindrical peripheral surface 32 of the shaft part.

The surfaces facing the shaft part of the radially outwardly extending parts of the ribs 22

can also lie, contrary to the the graphic illustration in Fig. 3, in the same plane as the peripheral surface 30 or they can, as can be seen from Fig. 3, extend obliquely to the plane 31 defined by the underside 30 of the head part 12 and be set back from this plane so that they do not project beyond the shaft side of this plane. The peripheral surface 30 and also the shaft side surfaces of the radially extending regions of the ribs 22 form the actual contact surface of the head part 12.

The closed fields 20 are at least substantially square in this embodiment when seen in plan view and this is in practice a relatively favourable shape for the fields 20. Other shapes of the enclosed fields 20, i.e. fields 20 which are bound at all sides, are also entirely conceivable in the context of the present invention. The rib parts 22 which are located in the contact region 18 of the head part 12 and which preferably extend in the radial direction become broader in the radially outward direction with the special design of Figs. 2 and 4. They merge steplessly without interruption into the peripheral surface 30 of the head part. In the present example eight ribs 22 are present, with the number of ribs preferably lying between six and eight.

It is evident from Figs. 1 and 3 that the peripherally closed fields 20 have their greatest depth (measured in the axial direction 35 of the element 10) adjacent to the shaft part 16. Although the peripheral surface 30 and the shaft side surfaces of the ribs 22 principally belong to the contact surface, the base surfaces of these closed fields can also be exploited as a contact surface by intentional deformation of the corresponding sheet metal part into the closed fields. In any event, it is possible, with the element of the invention, to provide a contact surface of large area so that the element can also be used with soft sheet metal parts without having to fear that a critical surface pressure results. It is particularly favourable when the base surfaces of the closed fields lie at least substantially on a conical surface with an enclosed angle of preferably 130 to 140° . This cone angle is indicated with the reference α in Fig. 3.

Furthermore, it can be seen from Figs. 1 and 3 that the element has a centering recess 34

which ensures a high-quality guidance of the element during insertion of the same. The element has, moreover, a conical insertion tip 36. This tip is not only of use when attaching the article which is later to be secured to the element but rather also during the guidance of the element in the setting head during the insertion into the corresponding sheet metal part.

The insertion method is schematically illustrated in Figs. 5 and 6.

Fig. 5 shows a setting head 38 of a joining tool 40 comprising a pressing and joining plunger 42 which is moveable in the direction of the arrow 43.

With reference to Fig. 5 the arrow direction 43 shows the supply direction of the element 10 in the setting head. The elements 10 are fed individually to the setting head 38. The element shown in Fig. 5 passes under gravity, optionally also under the action of compressed air or of the pressing and joining plunger 42, through the bore 44 of the setting head until the head part 12 of the element, which is partly spherically rounded for guidance purposes, enters into contact with a ball 48 biased by means of a spring 46. In practice three such spring biased balls are preferably provided, which are arranged at intervals of 120° around the longitudinal axis 50 of the setting head 38. At the stage shown in Fig. 5 the pre-apertured sheet metal part 52 into which the element 10 is to be inserted is already held between the setting head 38 and the riveting die 54 of a lower tool 56. The shaft part 16 of the element which is provided with a thread 14 has already partly passed through the pre-manufactured aperture 58 in the sheet metal part 52 and through a cylinder-like centering opening 60 of the riveting die 54 which is coaxially aligned therewith. The riveting die 54 itself is interchangeably supported within a bore 57 of the lower tool 56 belonging to the joining tool and is supported via a plate 59 on a lower press plate 61.

In the later stage of the insertion method the pressing and joining plunger 62 provided in the setting head 38 moves further downwardly and presses the head part 12 of the element past the three spring loaded balls 48. During this movement the crown region 64 of the riveting die 54 arranged coaxially to the hole 58 and to the axis 50 is pressed into the mate-

rial of the sheet metal part and this leads to the material of the sheet metal part flowing on the one hand into the closed fields 20 and on the other hand into the recess 28 and thus producing a reliable riveted connection between the element 10 and the sheet metal part 52, which then jointly form a component assembly .

It is particularly favourable when the riveting die 54 has the shape in the crown region which can be seen from Fig. 7. I.e. this crown region of the riveting die has a ring-like, wave-shaped end face which has crests 72 and valleys 74 extending in the axial direction to generate the plastic deformation of the sheet metal material. When using this riveting die the raised crests 72 serve to drive the material of the sheet metal into the concave fields 20 in the underside of the head part 12 of the element 10 and the valleys 74 come into contact against the sheet metal part in regions where the radially outwardly extending parts of the ribs 22 lie so that a pronounced thinning of the sheet metal material does not arise in the region of the ribs in accordance with the invention.

As a result of the clamping of the sheet metal material between the riveting die and the lower side of the head part 12 of the element 10 the sheet metal material is also forced to flow into the recess 28 so that the desired form-locked connection arises. A special measure for the angular alignment of the element 10 relative to the crests and valleys of the riveting die is in practice not necessary because, for energetic reasons, the element 10 attempts to turn in such a way that the potential energy is a minimum and thus adopts a position in which the crests 72 of the riveting die 54 are aligned with the concave fields 20, i.e. the requisite alignment takes place via a slight automatic turning of the element during the setting procedure.

As a result of the design of the riveting die a groove extending at least substantially coaxial to the longitudinal axis 35 of the element 10, and which may be an interrupted groove, is formed, as shown in Figs. 8 and 9, at the side remote from the head 12 of the element 10, as can best be seen from Fig. 9. This groove has a wave-shaped base surface, above all when the riveting die has the shape of Fig. 7. The crests of the wave-shaped base surface

should, however, not project beyond the lower side 7 of the sheet metal part in order to ensure a clean seat for the article which is to be secured to the sheet metal part. An exception to this exists, however, when the article is an electrical terminal. In this case the crest regions of the wave-shaped base surface can project beyond the lower side of the sheet metal part in order to ensure a higher surface pressure at the terminal, i.e. a better electrical contact.

The element of the invention can, however, also be differently formed than as a threaded bolt. For example, an element 10 in the form of a bearing spigot could be considered. I.e. the thread is replaced or supplemented by a cylindrical bearing surface.

The so described features of the head and the riveting of the head part with the sheet metal part also apply without restriction to the bolt element which will now be explained in more detail with reference to the following Figs. 10 to 15. For this reason elements of the drawings of Figs. 10 to 15, which are also to be found in the Figs. 1 to 9, will be provided with the same reference numerals and an additional description of the parts or functions characterised with the same reference numerals can be largely dispensed with, because the previous description also applies to the Figs. 10 to 15. Only the differences will be described in detail. In principle there are three main differences. these are the following differences:

a) the design of the end 100 of the bolt element 10 remote from the head part 12,

b) the punching through of the sheet metal part by means of its end 100,

c) the formation of a collar around the punched hole which is achieved by a somewhat modified shape of the die.

It is evident from Fig. 10 that the end 100 of the bolt element 10 remote from the head part 12 has a so-called Ka shape in accordance with DIN 78. I.e. the end 100 represents a spigot-like projection 101 with an outer diameter which is somewhat smaller than the core

diameter of the thread 14 and merges via a truncated, cone-shaped section 102 into the thread 14, with the cone angle of the truncated, cone-shaped section which diverges in the direction of the thread 14 amounting to 90° .

A plurality of wedge-shaped grooves 106 arranged parallel to the longitudinal axis are located at the periphery of the spigot-like projection 101 with the depth of the grooves (measured in the radial direction) reducing continuously from the end face 104 of the shaft part 16 and going to zero at the start of the conical section 102.

This special design of the end of a bolt element is admittedly known per se is, however, normally used for a quite different purpose, namely to enable the attachment of a nut, using automatic screwing devices in particular. The number of the wedge-shaped grooves is not so critical for the present invention. It is, however, particularly advantageous if a non-even number of such grooves 106, for example 5 such grooves, is/are provided.

Each groove is of V-shaped cross section, with the one side surface of the groove, for example the side surface 108 in Fig. 10, lying in a radial plane, while the other surface forms an angle with the radial surface 108.

Although the design of Fig. 10 represents a preferred embodiment, other embodiments can also be considered. For example, the grooves 106 in accordance with Fig. 10 could be formed as ribs. These ribs should lie within a circle coaxial to the longitudinal axis 50 of the bolt element, with the diameter of the circle being smaller than the core diameter of the thread 14.

The end face 104 can also be slightly concave or convex and could also possibly be formed as a point. The latter is, however, not particularly preferred because problems arise if the bolt element is not guided absolutely perpendicular to the sheet metal part. If only a slight tilting of the bolt element arises in the setting head, for example when the latter is somewhat worn, then an end of the bolt element formed as a point would be pressed into the

sheet metal part. A correction of the inclined position of the bolt element would then no longer be possible, i.e. the use of a bolt element with a pointed end is only restrictedly capable of satisfying the demands of the installation process.

The sequence of events for the attachment of a bolt element 10 to a sheet metal part will now be explained in more detail with reference to Figs. 12 to 15, with the Fig. 11 showing the finished component assembly comprising the bolt element 10 and the sheet metal part 52.

Fig. 12 shows the bolt element 10 in the setting head 38 and indeed during a working stroke of a non illustrated press in which the setting head 38 and the riveting die 54 are provided. The setting head 38 is namely secured to an upper tool (not shown) or to an intermediate plate (not shown) of the press and has been driven downwardly to the extent that the sheet metal part 52 is clamped between the end face of the setting head 38 and the oppositely disposed end face of the die 54. One sees that the ring-shaped raised portion 64 at the end face of the die 54, which can be formed in accordance with Fig. 7, has caused a slight upwardly directed bulge of the sheet metal part 52. During the further closing of the press during the working stroke the plunger 52 is moved further downwardly while the part of the setting head indicated in hatched lines deflects resiliently rearwardly relative to the upper tool of the press or of the intermediate plate of the latter. In Fig. 12 the plunger 42 has moved downwardly to the extent that the end face 104 of the bolt element contacts the sheet metal part 52. From Fig. 12 one can clearly see that the outer diameter of the spigot-like end 101 of the bolt element is substantially smaller than the inner diameter of the ring recess 112 at the end face of the die.

That is to say that the spigot-like projection 101 at the end 100 of the bolt element which acts as a cutting projection contacts the sheet metal part 52 which lies between the cutting projection and the die 54 lying beneath it, which is aligned coaxial to the central longitudinal axis 50 of the bolt element.

The ring recess 112 of the die merges via a ring shoulder in the form of a rounded shaping edge 113' into a section 114 with a diameter which is smaller than the inner diameter of the ring-shaped recess 112, but is, however, ca. 0.1 mm larger than the outer thread diameter of the bolt element 10.

The die 54 is held and secured in known manner in a stamping /shaping tool.

In Fig. 13 the bolt element has cut a slug 116 from the sheet metal part 52 under the influence of the force F resulting from the stroke movement of an upper tool of the press and has thereby generated a tubular deformation 120 in the shaped sheet metal part 52, with the tubular deformation being directed in the direction of the free space 118 of the die. One notes from the drawing that the side edges of the slug 116 are rough, and this also applies to the downwardly directed end face 112 of the ring-like collar 120, i.e. of the tubular portion.

What one does not, however, see in the drawing is that the wedge-shaped grooves have generated notches, cuts or tears in the sheet metal part which are particularly advantageous because they tear further under the action of the truncated, cone-shaped section 102 and reduce the forces which are necessary for the deformation of the sheet metal part in the area of the collar.

The force which is necessary in order to push the bolt element through the collar is correspondingly also reduced and this also applies to the further stage of the insertion method of Fig. 14, where the collar has been further dilated by the threaded part. In this manner the force acting on the thread has been reduced so that damage to the thread need not be feared.

In accordance with the drawing of Fig. 14 the bolt element has moved, as a consequence of the downwardly directed movement of the upper tool (riveting plunger 42), which causes a corresponding movement of the plunger 42, into the bore 124 of the die which forms a

guide. In doing so it has further broadened the tubular section of Fig. 13 and has largely moulded it in a form fitted manner into the ring recess 112 of the die.

This shaping of the sheet metal material takes place essentially by the first two thread turns of the bolt element. These thread turns can be made substantially harder (strength) using a known tempering process than the following thread turns which are associated with a specific strength class, for example 8.8. Damage to these thread turns is avoided by the increased strength. The hardening of the first thread turns of a bolt element is known per se in the art, and above all for self-tapping bolts. This increased strength can also be achieved with means known per se.

The punched slug 116 drops in the drawing of Fig. 14 through the free space 118 of the die 54 and can be disposed of in known manner.

In the stage of Fig. 15 the tool of the press is moving through the lower dead centre. As a result of the cooperation of the die 54 and the underhead shape of the bolt element 10, a form fitted locking of the sheet metal material and the head part 12 of the bolt element 10 takes place, as previously described with reference to the Figs. 1 to 9, with this riveted or locked connection tending to be of higher strength than for the known component assembly of the earlier German patent application P 44 10 475.8 consisting of a pre-apertured sheet metal part and bolt element. The reason for this is that in the present invention the collar makes material available in the critical region and this material is pressed during the deformation which occurs during closing of the press in a more complete manner into the ring recess and into the closed fields of the bolt element, whereby a higher permanent stress can be achieved in this region, which is favourable for the strength of the connection.

The component assembly of Fig. 11 results after opening of the press and removal of the sheet metal part with the bolt element riveted to it.

It is particularly favourable when the setting head or the method of German patent applica-

tion P 44 29 737.8 is used for the insertion of the bolt elements in accordance with the present application.

R/Sr-P 3490UA2

Patent Claims

1. Method of inserting a bolt element having a head part (12) and a shaft part (16) into a sheet metal part (52), or into another plate-like component consisting of deformable material, wherein the bolt element is guided by means of a setting head (38) through the sheet metal part (52) with its end remote from the head part at the front and is riveted to the sheet metal part in the region of its head part through the cooperation of the setting head (38) with a die (54) arranged on the side of the sheet metal part remote from the setting head (38), characterised in that the sheet metal part (52) is pierced by the end (100) of the shaft part (16) remote from the head part (12) under the action of the setting head (38), optionally in cooperation with the die (54).

2. Method in accordance with claim 1, characterised in that a slug (116) is formed on penetration of the sheet metal part (52).

3. Method in accordance with claim 2, characterised in that the hole formed in the sheet metal part (52) by the ejected slug (116) is broadened by the pushing through of the thread (14) formed at the shaft part (16) of the bolt element, preferably with simultaneous formation of a collar (120) which is located around the aperture and is dilated at the die side.

4. Method in accordance with claim 2 or claim 3, characterised in that the end (100) of the shaft part (16) remote from the head part (12) is used not only to push out the slug (116) from the sheet metal part (52), but rather also to generate at least one and preferably a plurality, and in particular a non-even number of notches, or at least substantially radially directed cuts or tears in the rim of the aperture.

5. Method in accordance with claim 3 or claim 4, characterised in that a bolt element

(10) is used which has a spigot-like projection (101) at its end (100) remote from the head part (12), with the projection having a diameter which is somewhat smaller than the core diameter of the thread, with features (106) which exert a cutting action preferably being provided at the spigot, for example in that the end of the bolt element has a so-called Ka-shape in accordance with DIN 78.

6. A bolt element (10) which can be inserted by riveting into a sheet metal part (52), the bolt element (10) consisting of a shaft part (16) and a head part (12) formed in one piece therewith, in particular for carrying out the method in accordance with one of the claims 1 to 5, wherein the rivet connection to the sheet metal part takes place in the region of the head part (12) and, on using the bolt element, the shaft part (16) which is preferably equipped with a thread is to be passed through the sheet metal part, characterised in that the shaft part (16) is formed at its end remote from the head part (12) to punch through the sheet metal part.

7. Bolt element in accordance with claim 6, characterised in that the end (100) of the shaft part (16) remote from the head part (12) has a spigot-like projection (101), the outer diameter of which is smaller than the core diameter of the shaft part, which is preferably provided with thread.

8. Bolt element in accordance with claim 7, characterised in that the spigot-like projection (101) merges via a truncated cone section (102) into the thread, the truncated cone section preferably having a cone angle of approximately 90°.

9. Bolt element in accordance with claim 7 or claim 8, characterised in that the spigot-like projection (101) has at least one, and preferably a plurality of cutting features (106), in particular a non-even number of cutting features which, on punching through the sheet metal part, slightly notch or tear the rim of the aperture at the respective positions.

10. Bolt element in accordance with claim 9, characterised in that the cutting features

(106) are formed by grooves which extend in the longitudinal direction of the projection (101) and which are in particular of V-shape in cross-section and the depth of which reduces in the axial direction of the shaft part in the direction towards the thread and preferably goes to zero in front of the thread, with the one side wall (108) of each V-shaped groove preferably lying in a radial plane.

11. Bolt element in accordance with claim 9 or claim 10, characterised in that the spigot-like projection is a so-called Ka-shape in accordance with DIN 78.

12. Bolt element in accordance with claim 9, characterised in that the cutting features are formed by ribs on the spigot-like projection in the longitudinal direction thereof, with the ribs preferably lying within a circle coaxial to the thread, the circle having a diameter smaller than the core diameter of the thread.

13. Bolt element in accordance with one of the preceding claims, characterised in that the end face (104) of the shaft part remote from the head part (12) is a surface which is at least substantially perpendicular to the central longitudinal axis of the bolt element and which can optionally be slightly concave or convex.

14. Bolt element in accordance with one of the preceding claims 6 to 13, characterised in that the first thread turns of the thread (14) are made substantially harder than the following turns of the thread.

15. Bolt element in accordance with one of the preceding claims, characterised in that the head part (12) of the bolt element is formed in accordance with the German patent application P 44 10 475.8, and in particular in that the element (10) has peripherally closed fields at its concave lower side serving as a contact surface (18), with the concave fields being at least partly bounded by ribs (22) extending outwardly away from the shaft part (16), and with the shaft side ends (24) of the ribs (22) extending in raised form along the shaft part (16) and merging at the ends (26) remote from the head part (12) into at least one

recess (28) extending spirally around the shaft part.

16. Bolt element in accordance with claim 15, characterised in that the shaft part (16) of the element has a larger diameter in the region of the raised ribs (28) in comparison to the shaft part (16) remote from the head part (12), with the at least one recess (28) being located in this region of greater diameter.

17. Bolt element in accordance with claim 15 or claim 16, characterised in that the peripherally closed fields (20) have their greatest depth adjacent to the shaft part (16).

18. Bolt element in accordance with one of the preceding claims 15 to 17, characterised in that the proportion of the area of the fields in comparison to the contact surface (18) of the head part are so selected that they result in an ideal security against rotation and non-critical surface pressure taking account of the material pairing.

19. Bolt element in accordance with one of the preceding claims 15 to 18, characterised in that the closed fields (20) are bounded at their radially outer boundary by a peripheral surface (30) of the head part (12).

20. Bolt element in accordance with one of the preceding claims 15 to 18, characterised in that the rib parts (22) which are located in the contact region of the head part (12) and preferably extend in the radial direction become broader radially outwardly and merge without interruption into a peripheral surface (20) of the contact region (18) of the head part (12).

21. Bolt element in accordance with one of the preceding claims 15 to 20, characterised in that the number of ribs (22) preferably lies between 6 and 8.

22. Bolt element in accordance with one of the preceding claims 15 to 21, characterised in that the closed fields (22) are at least substantially square in plan view.

23. Bolt element in accordance with one of the preceding claims 15 to 22, characterised in that the base surfaces of the closed fields (20) lie at least substantially on a conical surface having an included angle (2) of preferably 130° to 140° .

24. Bolt element in accordance with one of the preceding claims 15 to 23, characterised in that the side of the head part (12) remote from the contact surface (18) has a centering recess (34) extending coaxial to the longitudinal axis of the element.

25. Bolt element in accordance with one of the claims 15 to 24, characterised in that the element (10) has a thread (14), with the at least one spiral recess (28) being formed by a thread groove.

26. Bolt element in accordance with one of the preceding claims 6 to 25, characterised in that it is a functional part, for example a bearing spigot.

27. Riveting die, in particular for use with a bolt element in accordance with one of the preceding claims 6 to 26, characterised in that, for the generation of a plastic deformation of the sheet metal material, it has either a peripherally extending wave-like end face having hills (72) and valleys (74) in the axial direction, or has a roof-like ring wall at the end surface, with the end surface having a central ring recess with a diameter larger than the outer diameter of the thread and which merges via a ring shoulder in the form of a rounded forming edge into a smaller diameter which is fractionally larger than the outer diameter of the thread .

28. Component assembly comprising a sheet metal part (52) and a bolt element (10) in accordance with one of the preceding claims 6 to 26, wherein the metal of the sheet metal part (52) is at least partly plastically deformed into the closed fields (20) and into the at least one recess (28).

29. Component assembly in accordance with claim 28, characterised in that the sheet metal part (52) has a groove (80) which extends at the side opposite to the contact surface (18) of the head part (12) substantially coaxial to the longitudinal axis of the element and which is optionally interrupted.

30. Component assembly in accordance with claim 29, characterised in that the groove (80) has a wave-like base surface (81).

31. Component assembly in accordance with the claims 28, 29 or 30, characterised in that regions which are raised above the plane of the sheet metal part (52) are provided between the groove sections of an interrupted groove (80) for electrical contact purposes.

(Fig. 14)

Nummer: DE 195 35 537 A1
Int. Cl.⁶: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 1

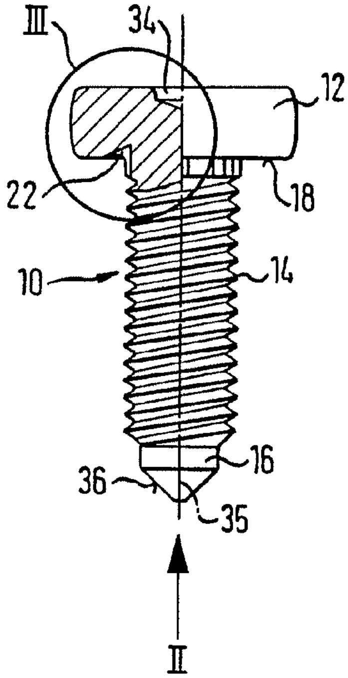


Fig. 3

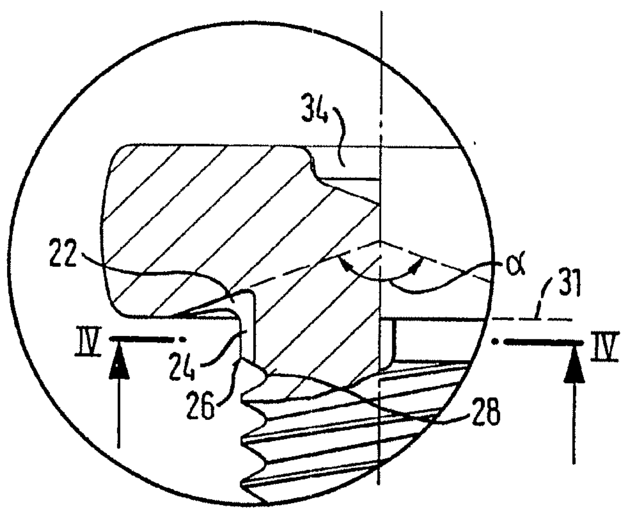


Fig. 2

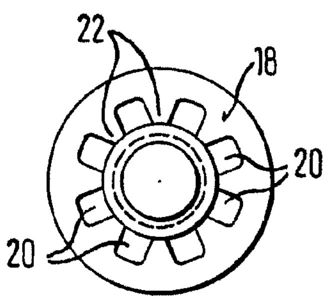
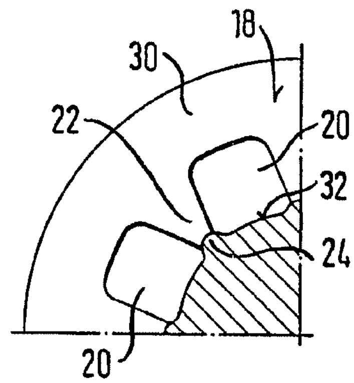


Fig. 4



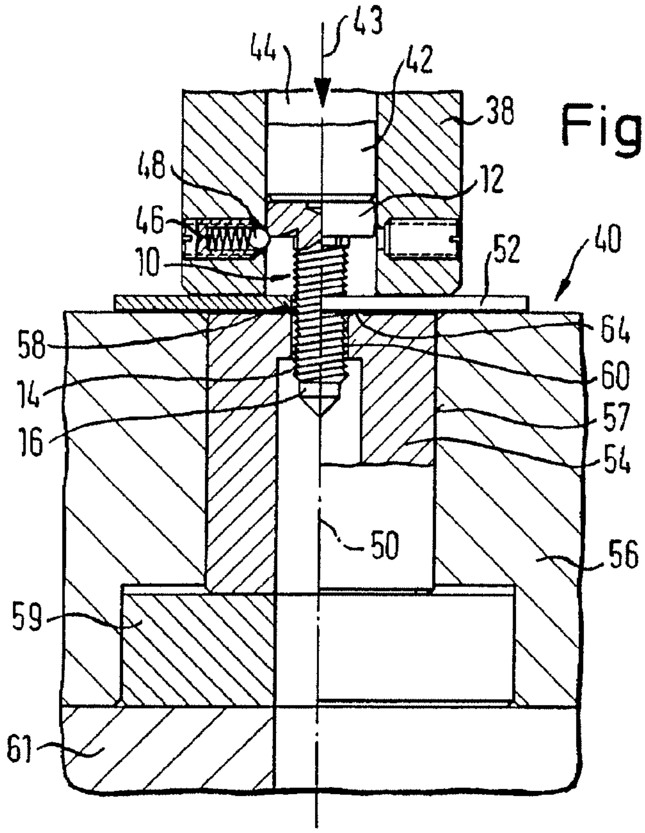
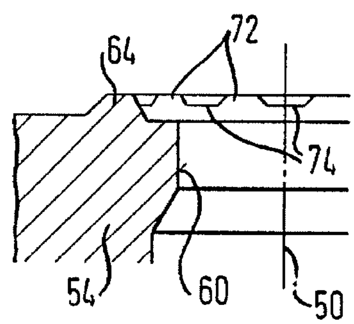


Fig. 5

Fig. 7



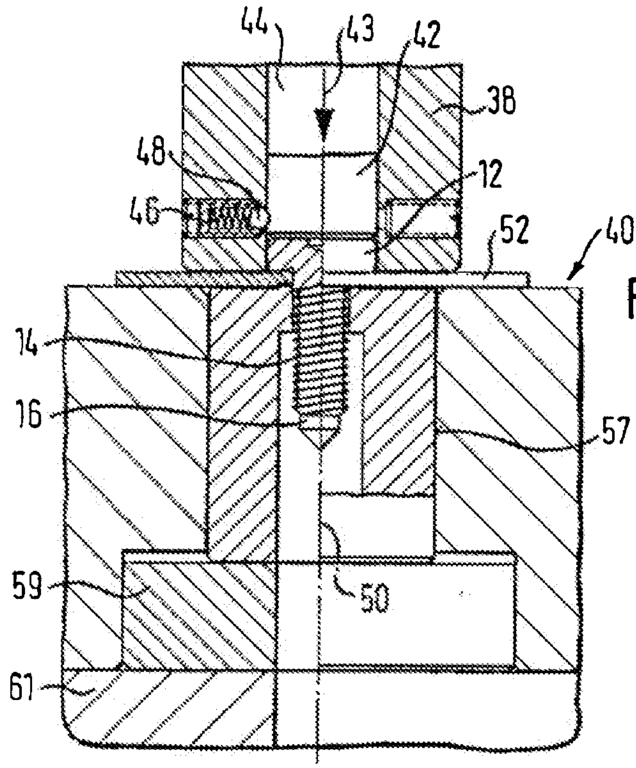


Fig. 6

Nummer: DE 195 35 637 A1
Int. Cl.[6]: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 8

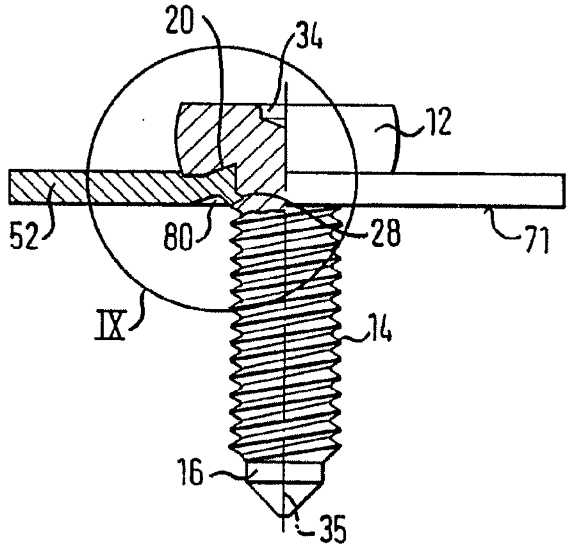
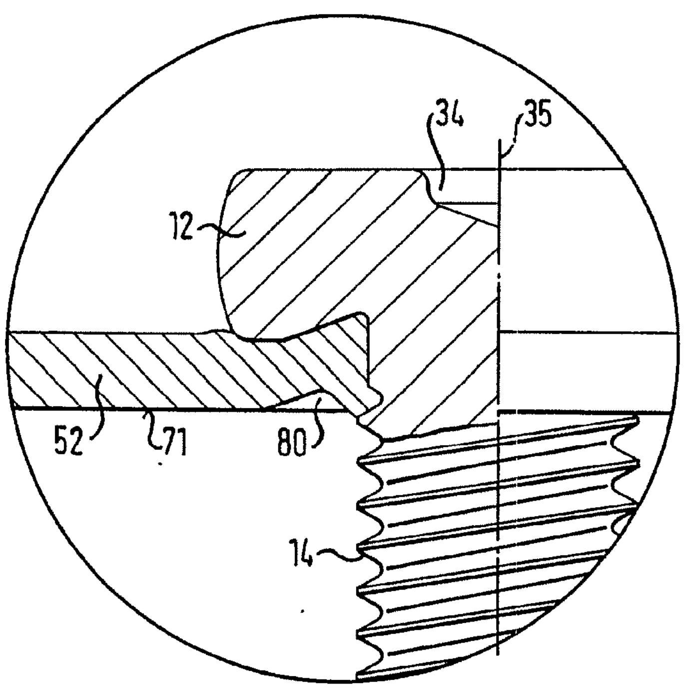
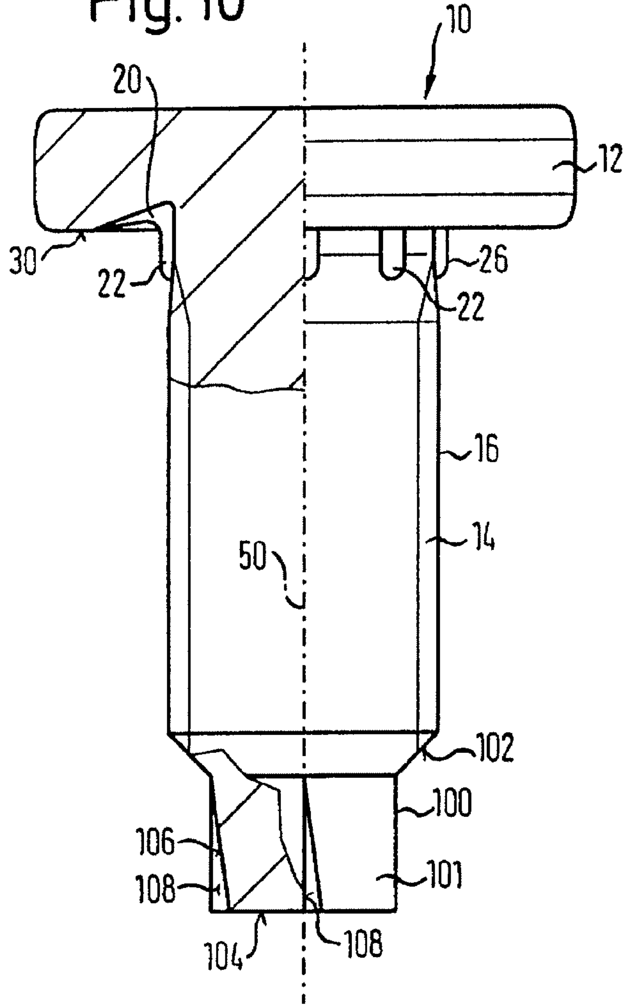


Fig. 9



Nummer: DE 195 35 537 A1
Int. Cl.⁶: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 10



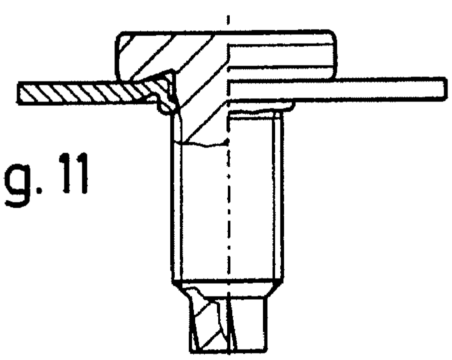
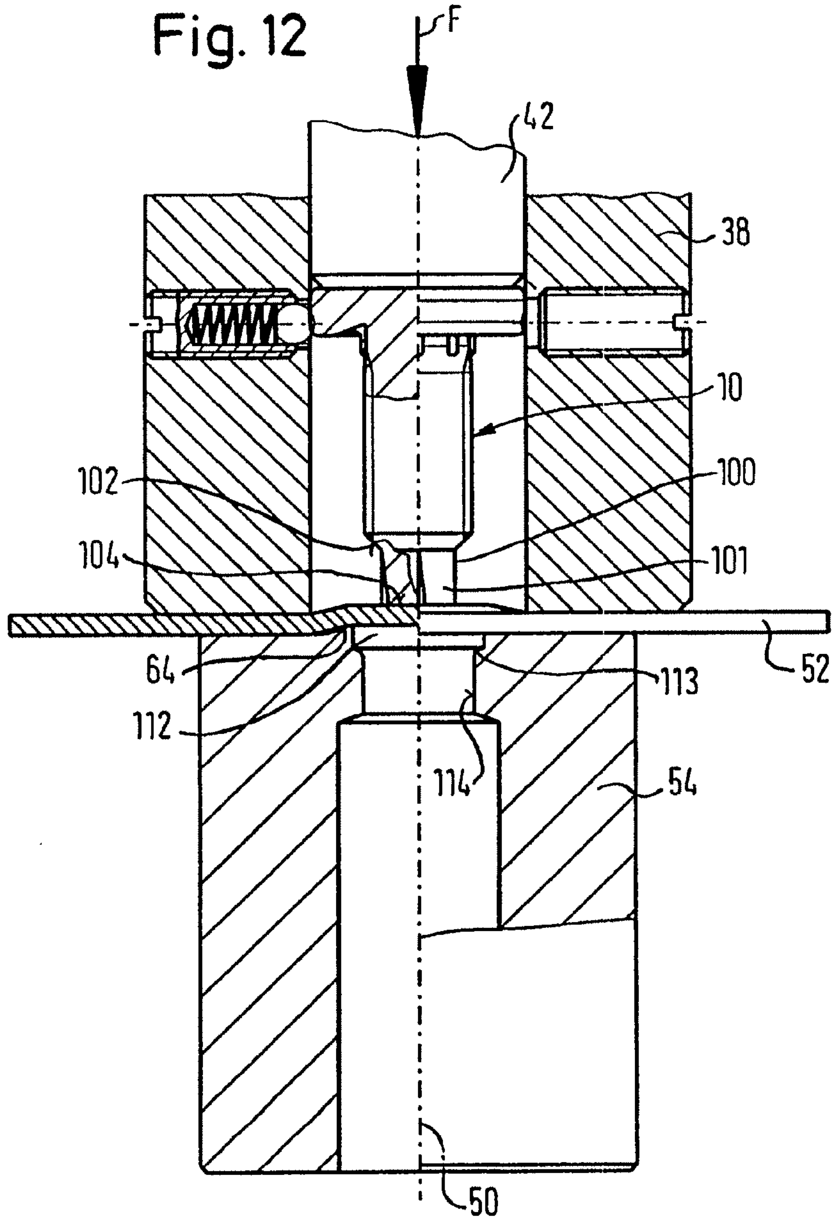


Fig. 11

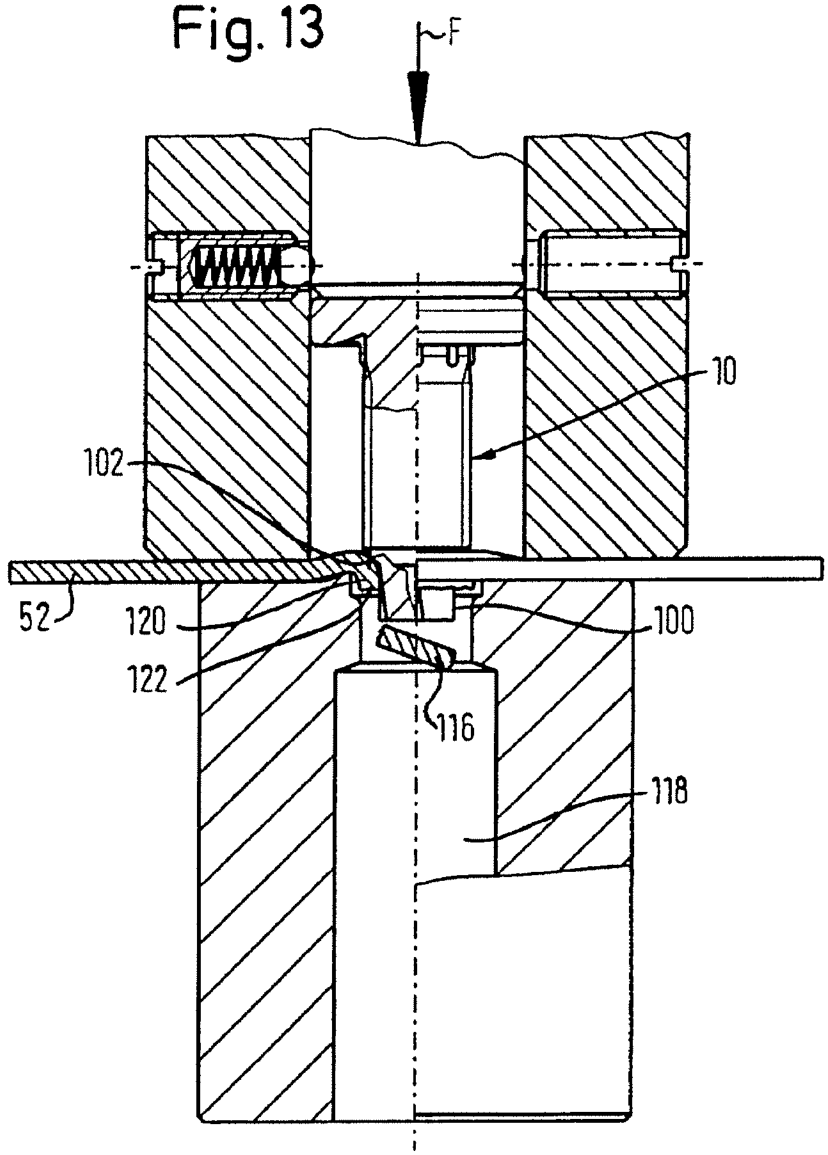
Nummer: DE 195 35 537 A1
Int. Cl.⁶: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 12



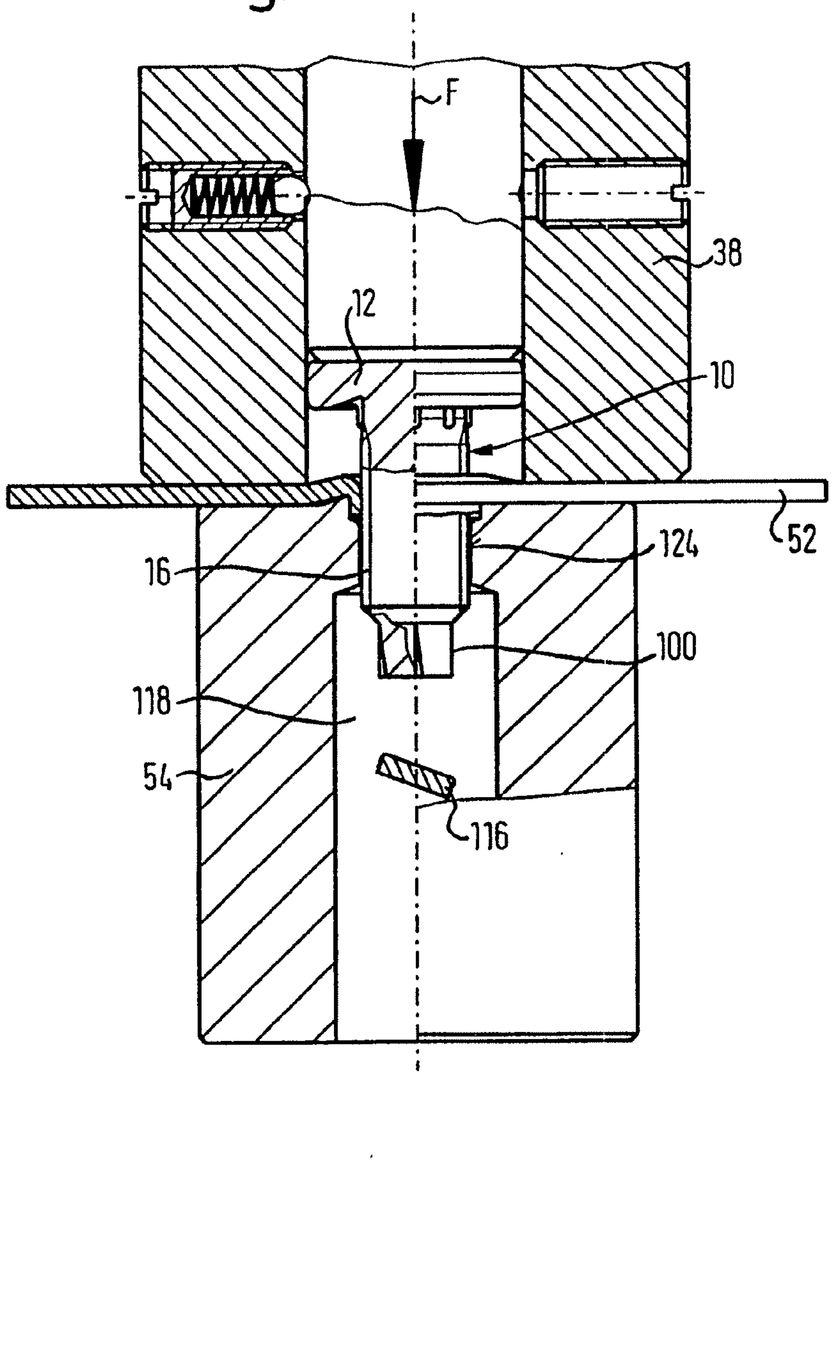
Nummer: DE 195 35 537 A1
Int. Cl.⁶: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 13



Nummer: DE 195 35 537 A1
Int. Cl.⁶: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 14



Nummer: DE 195 35 537 A1
Int. Cl.⁶: B 23 P 11/00
Offenlegungstag: 27. März 1997

Fig. 15